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XLII.—*On the Capitellæ and their Position in the System of the Annelida.* By EDWARD GRUBE\*.

By the communications published by Van Beneden† upon the genus *Capitella*, Blainv. (*Lumbriconais*, Oerst.), and especially upon *C. capitata* (*Lumbricus capitatus*, Fab.), our knowledge of this very peculiar Annelide has been most essentially advanced. These statements not only complete what has been ascertained by A. S. Oersted‡ and Leuckart§ as to the external structure and the nature of the intestinal canal, but they also include the whole remaining organization, the sexual relations (the divergence of which from those of the *Lumbrici* was previously indicated by Leuckart), and furnish results which are confirmed by investigations carried on independently. When I was at Copenhagen in 1856, Oersted laid before me a series of drawings relating to the anatomy of the *Capitellæ*, and incited me, during my stay there, to convince myself of the many peculiarities which had occurred to him in the course of his observations, and amongst which the presence of numerous definitely formed and comparatively large red corpuscles in the somatic cavity, the remarkable partial inflation of the body, and the entire deficiency of blood-vessels, had most struck him. He had also learned how to distinguish males and females by their external and internal structure, and believed that he had recognized the anterior part of the nervous system. The occurrence of these Annelides in the great

\* Translated by W. S. Dallas, F.L.S., from Wiegmann's Archiv, 1862, p. 366.

† "Hist. Nat. du genre *Capitella*," Bull. de l'Acad. Roy. de Belgique, sér. 2. iii. Nos. 9, 10 (1857).

‡ "Conspectus generum specierumque Naidum," Krøyer's Tidssk. iv. 1842, p. 128, pl. 3. figs. 6, 10, 11.

§ Beiträge zur Kenntniss wirbellos. Thiere (1847), p. 151; and Archiv für Naturgeschichte, xv. (1849), p. 163.

channel of Copenhagen enabled me, in the few days of my residence there, to repeat these extremely interesting observations on a series of specimens; but although we then (at the end of July) still found ova in many females, we did not succeed in detecting spermatozoa in the testes of the males: these Oersted had represented of a more fusiform shape than Van Beneden, and with a more acute anterior extremity and a shorter terminal filament. That I did not at once comply with Oersted's request to make known these observations was due partly to the want of a micrometer; for it appeared to me to be necessary to give the diameter of the corpuscles which floated in the somatic cavity. A second independent confirmation of Van Beneden's investigations has lately been given by Claparède\*, who, without any acquaintance with them, observed the same species in the Hebrides, but was not able any more than myself to subject the sexual peculiarities to a complete examination.

As regards the fluid of the somatic cavity and the red corpuscles contained in it in such abundance, Claparède also expresses himself in favour of its analogy with the blood. Van Beneden describes the corpuscles as "globules," and says that their form is lenticular; I convinced myself, during their flow from a wound in the wall of the body, that they are disciform and circular, as they show to the observer sometimes their broad surface and sometimes their margin. Claparède also calls them "*disques*," and I could almost think that they are biconcave like the blood-corpuscles of the Mammalia: that they contain a true nucleus, as stated by Van Beneden and Claparède, could not be ascertained positively by Prof. Reichert and myself—what might have been taken for a nucleus appearing only to adhere accidentally, and to be one of the corpuscles which also occur free in the somatic cavity; and the employment of acetic acid did not succeed in producing a more distinct appearance of a nucleus. By the action of this reagent the disks scarcely became somewhat smaller; and whilst their outer margin still remained circular, their interior appeared as if crumpled or granulated, minute sharply-defined granules being distinguishable therein.

In ether they become decidedly more irregular, and the margin and interior become more sharply discriminated. I must, however, remark that I have observed all this only upon *Capitella* which were sent to me in Breslau by the kindness of Prof. Van Beneden, and which, being favoured by the December weather, arrived indeed still living, but by no means lively in appearance; nevertheless even the broken or half-dead specimens exhibited no essential difference in this respect. The diameter

\* Mémoires de la Soc. de Phys. et d'Hist. Nat. de Genève, 1861, p. 110, pl. 1.

of the corpuscles is given by Claparède at 0.010 mill. (= 0.005 line); I found it to be greater, namely 0.006–0.008 line, or about one-tenth of the length of the shorter uncini. As far as I can remember, those observed in Copenhagen presented a similar proportion, although, from the small size of the animals examined by me (most of them measured only 5 lines), they appeared to me to be uncommonly large. The corpuscles flowed, with the fluid of the somatic cavity, from one segment into the other, above and below the ligaments (or dissepiments, as Van Beneden calls them) which fasten the wider portion of the alimentary canal to the wall of the body. This occupied by far the longest part of the body, and in a specimen of thirty-three segments (such as most of those examined by me in Copenhagen) extended through sixteen of them, increasing slowly in width towards the middle. The œsophagus, about half the size, usually reached in repose, when it describes one or two curves, into the ninth segment; the end of the intestinal canal, which, again, is considerably thinner, and lies in short convolutions, usually passed through from four to nine segments; but even in the hindermost part of the wider division of the alimentary canal I detected balls of excrement. In the extremely narrow lumen of the very muscular œsophagus, which is linear in repose, I repeatedly observed ciliary movement.

The uncini, which stand four or five together on the segments, one or two on the hindermost segments, were moved, as far as I could see, in the same way as the setæ, single muscular threads proceeding from the wall to attach themselves to the free end of the bundle which projects into the ventral cavity. Sometimes in one of the bundles of setæ, which occur only on the first seven segments (or eight, according to Van Beneden), and also contain four or five setæ, single setæ were replaced by uncini, but only in one, two, or three of the hindermost of them: Van Beneden gives this as the rule. Oersted called my attention to a flat, nearly oval body, running out, as it were, into two lobes, which was discovered by him lying over the buccal cavity, and which he thought to be the superior ganglionic mass of a buccal nervous ring. I regard this interpretation as the more probable because there was on each of the two lobes a well-defined black point, having exactly the appearance of an eye-point. Claparède also notices these points, but adds that he could not detect a lens in them.

Ova, which I observed in a specimen at Copenhagen, occurred neither in paired sacs repeated in the segments nor in the somatic cavity, into which they get from these, according to Van Beneden, but in two delicate-walled sacs situated at the sides of the intestine, which commenced at the twelfth segment and

reached to the seventeenth, and the diameter of which was not much greater than that of an ovum.

D'Udekem\*, in his "Classification," also speaks only of two ovaries. In one of the specimens from Ostend, sent to me in March by Van Beneden, I likewise found ova; their diameter was 0·05 line, and that of their germinal vesicle 0·0015 line. Upon the organs secreting urine, which, according to d'Udekem, are situated in almost all the segments of the body, I have made no observations.

The remarkable anchor-shaped *Gregarinæ* which Oersted discovered in the intestine of his *Capitellæ* have also been found by Van Beneden, Leuckart, Claparède, and myself. Claparède's figure† shows a completely developed form, in which the nucleus is indicated merely by the pale spot in the foremost third of the body. In younger animals, in which the body is not yet so much filled with greenish mass, this nucleus appears far more distinctly: it is sometimes nearly circular, sometimes oval, contains a nucleolus, and is situated nearly always in the same spot, but sometimes more anteriorly, between the bases of the arms of the anchor. As the median body increases in length and becomes more slender, these arms also gradually grow out; they are at first very short, like two mere teeth, and extended horizontally; and in still younger states, where the length of the body is still scarcely one-fourth of that of the mature animal, no trace of them is to be seen, the form of the animal being then a rhomb with rounded angles, much produced posteriorly. This entire series of changes, of which I only saw a few, has been observed by Oersted.

The next question which presses upon me is, whether the *Capitellæ* observed in Copenhagen, and those found at Ostend, on Heligoland, and on the Hebrides, belong to one and the same species with the *Lumbricus capitatus* described by Fabricius. The differences of size of sexually mature individuals are very considerable: whilst Oersted states the length of his *Lumbriconais marina* at 10 or 12 lines, and I even had males of only 5 lines, Van Beneden found the males 24–27 lines and the females as much as 4 inches long; Claparède sometimes found them still longer, and Leuckart even met with specimens as much as 7 inches in length. The indication of Fabricius—"longitudine Lumbrici terrestris"—shows that, although, according to his statement, the Greenland animals of this species do not attain such large dimensions as the Norwegian (amongst which he mentions one a foot in length), his specimens were certainly of the larger kind. The *Capitellæ* from Greenland

\* Mémoires de l'Acad. Roy. de Belgique, xxxi. 1859, p. 25.

† Mémoires de la Soc. de Phys. et d'Hist. Nat. de Genève, pl. 1. fig. 15.

which I possess are 1·3 line in thickness and more than 2 inches in length. In the same way the number of segments varies, in accordance with the size, from thirty-three and forty-five (in the small Copenhagen specimens) up to sixty and eighty-two; in all the males examined by Van Beneden, Oersted, and myself, it is on the eighth and ninth segments that the peculiar, large, crooked ventral setæ occur, and in the ninth that the sexual orifice and the testis are situated\*. In the number of bristles there is a remarkable diversity. Van Beneden gives eight as the normal number both in the bundles of setæ and in the transverse rows of uncini. I counted in the Copenhagen specimens never more than four or five, in many Belgian ones twelve, and in the Greenland specimens twelve or more setæ, and far more than twelve (even nearly thirty) uncini, of which, however, those standing nearest to the median line of the ventral surface were scarcely distinguishable, whilst in the opposite direction they increase considerably in length. As the smallest number of bristles belongs to the smallest specimens, it may easily be supposed that the number increases with the growth; and in these diversities, as in those already mentioned, I see no inducement to the assumption of two species, but rather believe that the *Capitellæ* of the Baltic, like many other animals which it has in common with the North Sea, do not attain such large dimensions as in the latter.

I must further indicate that Dalyell's *Lumbricus capitatus*† does not belong here, but that the *Lumbricus capitatus* described by Johnston‡, the length of which was from 3 to 6 inches, is the same species, and that he also united with it his previously described *Lumbricus littoralis*§, which he had characterized as "aculeis uniserialibus." That he assumed for the blood, the very irregular ebb and flow and grumous masses of which also struck him, two lateral vessels situated between the intestine and the wall of the body, may be easily excused if he did not perseveringly observe. He himself says that the movement of the blood appears to depend upon the movements of the body and the extension of its segments. The synonym of *Lumbricus fragilis*, Müll., which is now recognized as a *Scoloplos*, is only cited by him with doubt. Our Annelide is also regarded by Fabricius as identical with Olafsen's *L. littoralis minor* from

\* Van Beneden's statement of the ninth and tenth segments (p. 17) appears to be a mere printer's error, his figure representing the eighth and ninth as those in question. In a specimen from Greenland, I find these bristles, singularly enough, not on the ventral, but on the dorsal surface!

† The Powers of the Creator, vol. ii. 1853, pl. 17. figs. 8, 9.

‡ Loudon's Mag. Nat. Hist. vol. viii. p. 258.

§ Zool. Journ. iii. p. 328.

Iceland. But the distribution of *Capitella capitata* is not closed with the Icelandic and English coasts; for the *Lumbricus canalicium*, mentioned *en passant* by Nardo as an inhabitant of some of the shallower and less frequented canals of Venice\*, is likewise nothing but our *Capitella*, as I have ascertained by the examination of the spirit specimens captured by him. Whether it also occurs on the French coast has not yet been ascertained.

The determination of the position which the genus *Capitella* should occupy in the system appears to Claparède not to be settled by the discussion with which Van Beneden closes his memoir; and I am of the same opinion. Van Beneden comes to the conclusion that the *Capitellæ* are dioecious Lumbricinæ: all that can be cited in favour of the supposition that they belong to the Polychætæ is limited to the mode of development, to the form of the embryos, which escape into the world with a globular body, with two eyes and two tufts of cilia close to these, and then pass through a metamorphosis, a posterior circlet of cilia being added to the ciliary circlet before the eyes, which originates in the above-mentioned tufts, and the portion of the body between these extending itself and dividing into rings; the absence of vessels and the distribution of the male and female sexual organs upon two individuals are not of sufficient importance to have much stress laid upon them. But what is there positively in favour of referring the *Capitellæ* to the Lumbricinæ, and in what signification is this name taken? It does not correspond with the family which I have established under this name, as Van Beneden also refers to it *Tubifex* (*Sanuris*), *Enchytraeus*, and *Chætogaster*, but rather to D'Udekem's suborder of *Agemmes*, which forms the opposite to his *Gemnipares* (the *Naidés*). As the Lumbricinæ, in D'Udekem's sense, include nothing but Annelides with series of but slightly projecting uncini standing singly or in pairs, *Capitella* would approximate to them less than to *Tubifex*, a genus three of the six species of which occur in the sea; whilst for the *Lumbrici* the proportion of marine forms is far less favourable.

The organization of the *Agemmes* is expressed (besides the occurrence of uncini, rarely also of setæ) especially in the concentration of the genital organs in certain limited regions of the body, in their hermaphroditism, and in the appearance of the so-called *loop-like organ*; whilst external organs of respiration never appear (except in *Alma nilotica*). If, therefore, the *Capitellæ* be, as Van Beneden supposes, *Lumbrici* of a low degree of organization, this degeneration of the type shows itself in the disappearance of the blood-vessels and the simpler arrangement of

\* Prospetto della Fauna marina volgare del Veneto estuario, 1847, p. 11.

the generative organs. As something new added, we have the large curved bristles at the orifice of the testis, the arrangement of the bristles in lateral rows, the separate sexes, the different structure of the ova, and the metamorphosis of the young; but it must certainly be admitted that we do not know the young states of the marine forms of the *Agemmes*; and whether these pass through a metamorphosis it is as impossible to predict as it was to suppose, in the case of the Lobster, that it follows a different course of development from that of its nearest ally the river crayfish.

Turning to the Polychætæ, would it be more difficult to find among them forms with which the *Capitellæ* could be arranged? I admit that, however I was determined by Oersted's first communications, and before I had myself seen these animals, to follow him and place them among the Naïdes, I afterwards hesitated about leaving them in this position; and at the first sight of a large spirit specimen I thought no more either of the Naïdes or of other Oligochætæ. In this specimen the segments were proportionally considerably longer, in the anterior portion of the body, furnished only with setæ, half as long, in the posterior portion, bearing uncini, one and a half times as long as broad; moreover the uncini were grouped in regular combs, and inserted in distinct ridges. This had also struck Claparède, and appeared to him so important that he approximated the *Capitellæ* to the *Maldaniæ*\*, which, indeed, stand near the Lumbricinæ, according to the views of Cuvier and Milne-Edwards, but were placed by Savigny and Lamarck, with whom I agreed, near the *Arenicolæ* and *Terebellæ*. For my own part, I was more vividly reminded of the genus *Dasybranchus* (olim *Dasy-mallus* †) and of *Notomastus*‡. If Van Beneden only assumes that the evolution of the organization in the Lumbricinæ may retrograde, and the vascular system disappear, this decidedly takes place among the Polychætæ. As regards the respiratory organs, in the first place, we find, in the genus *Eunice*, together with species with greatly developed branchiæ (such as *E. gigantea* and *E. Harassii*), others with very rudimentary branchiæ (such as *E. siciliensis*), and, in the genus *Lumbriconereis* (in the wide sense), species with very simple branchiæ, and others with none at all. Quatrefages§ has already shown by examples how, besides the Polychætæ with a vascular system ramifying everywhere, others occur in which it is only partially developed, and others, again, in which it is entirely wanting; and in the latter

\* Mémoires de la Soc. de Phys. et d'Hist. Nat. de Genève, 1861, p. 110.

† Archiv für Naturgeschichte, 1846, p. 166, tab. 5. fig. 3.

‡ Sars, Fauna litt. Norveg. ii. p. 11, tab. 2. figs. 8-17.

§ Ann. Sc. Nat. sér. 3, Zool. xiv. pp. 268, 294, 296.

the corpuseles contained in the fluid of the somatic cavity appear more numerous and more highly developed. I have hitherto been unable to detect blood-vessels in the *Dasybranchi*, either in the living state or in a spirit specimen; their branchiæ seem to resemble those of the *Glyceræ*, forming a diverticulum of the somatic cavity, and taking up its fluid when they extend themselves. Just as the *Glyceræ* stand near Polychætæ with vascular branchiæ, I place the *Dasybranchi* near the *Arenicola*. The *Notomasti*, however, agree so closely with the *Dasybranchi* that they are essentially distinguished only by the want of branchiæ. In them also I have hitherto detected no blood-vessels; but in a living specimen, I distinctly saw a red fluid moving between the intestine and the body-wall; its accumulation caused the segments to dilate, and it consisted almost entirely of circular corpuseles, 0.006 line in diameter; in a spirit specimen, which wanted the posterior half, I found regular balls of apparently similar corpuseles in the somatic cavity. With regard to the alimentary canal, the same statements apply to both genera: it commences with a rather short protrusible pharynx, surrounded by pro- and re-tractor muscles, forming a proboscis; then follows a narrow tube (œsophagus or stomach?); and about where the change of bristles takes place this tube passes into an intestine embraced by dissepiments, the anterior part of which, in the spirit specimens examined, is not wider than the tube, and is narrower than the posterior portion, which is usually filled with much excrement. The distinctly double nervous cord, with separated inflations, shows the greatest similarity to *Lumbricus*\*, and the arrangement of the muscular system to *Arenicola*.

I must further remark that in both genera the bristles are grouped on each side in two rows; that on the anterior segments only setæ, and on the remainder, which are far more numerous, only uncini, occur: the former stand in very short transverse rows behind narrow and low ridges; the latter in combs upon ridges. It is worthy of notice that the projecting part of both kinds of bristles is bordered†—a peculiarity which occurs frequently in the setæ of the Polychætæ, although very rarely in the uncini (as in several genera of Eunicææ, on individual segments in *Leucodore* and *Colobranthus* among the Ariciadæ), but which I have not met with among the Oligochætæ.

If we return again to the *Capitellæ*, everything that I have just explained is repeated, leaving out of consideration the generative organs and the sexual relations in general, as to which, in *Dasybranchus* and *Notomastus*, I can say nothing; and in treating of generic characters it would be difficult to state how

\* See Cuvier, Règne Animal, Annelid. pl. 1, fig. 2.

† Van Beneden, *l. c.* pl. 1. figs. 8, 9; Claparède, *l. c.* pl. 1. fig. 12.



the *Notomasti* are distinguished from the *Capitellæ*. Nay, it may even appear questionable whether *Dasybranchus* and *Notomastus* are to be generically separated; for if it be confirmed that some *Glyceræ* are destitute of branchiæ, and the presence of these organs here furnishes no generic character, the same thing might be applied to *Dasybranchus*. In both, the superior combs of uncini at the commencement of the posterior division of the body are brought quite upon the back, and are much narrower than the inferior ones, by which *Notomastus* acquires a greater similarity to *Dasybranchus* than to *Capitella*; it is also only in these two that a proboscis (protrusible pharynx) is observed; nevertheless, from what I have seen in the anatomy of a *Capitella*, I must assert that in them also the commencement of the alimentary canal can be turned out. The *appareil sécrétoire rénal*, which D'Udekem describes in *Capitella*, I have hitherto been unable to find in *Dasybranchus* and *Notomastus*; but the specimens examined by me were not in the best possible condition; and it would be very important, in future investigations, to pay attention to this point.

The large curved bristles which appear in a transverse series before and behind the genital orifice of the male, and have their apices directed towards each other, have hitherto only been observed in the *Capitellæ*; they may perhaps be regarded as a transformation of the combs of small bordered uncini, which are wanting on the segments in question. But are we acquainted with the males of *Dasybranchus* and *Notomastus*? Perhaps they may possess a similar character. At any rate, these organs remind us of the two strong hook-like bristles (spicula) which are so striking on the ventral surface of the *Thalassemæ*, *Echiuri*, and *Bonellie*, and are likewise placed before the paired and median genital orifices of these animals. In the *Echiuri* a posterior pair is also concealed within the skin\*. The more distinct separation or partial amalgamation of the genera *Dasybranchus*, *Notomastus*, and *Capitella* must be left for further and more accurate investigations; but I think I have demonstrated that these three genera stand in a close relationship, and must be referred to one family, the *Capitellaceæ*, which, in my opinion, are related to the *Arenicolæ* in the same way as the Gephyrei without vessels and with a highly developed fluid in the somatic cavity to the Gephyrei with vessels. The development of the *Capitellæ*, upon which we have such interesting information from Van Beneden, and which so much resembles that of the *Arenicolæ*†, the form of the ova, and the separation of the sexes, all agree

\* M. Müller, Obs. Anat. de Verm. quibusd. marinis, 1843, p. 11.

† Schultze, Ueber die Entwicklung von *Arenicola piscatorum*, Halle, 1856; transl. in Ann. Nat. Hist. ser. 2. vol. xviii. pp. 105 et seq.

excellently with the rule in the section of the Polychætæ, and would form an exception if we referred the *Capitellaceæ* to the Oligochætæ; this applies also to the absence of the vascular system, and to the form of the bristles and their insertion in ridges.

With regard to the distinctions between *Dasybranchus* and *Notomastus* indicated by Sars\* in addition to the occurrence and want of branchiæ, I will only remark that, in well-preserved small spirit specimens of *Dasybranchus caducus*, the two-ringed nature of the segments is very distinct, and the proboscis of such a specimen appears not so much scaly as covered with papillæ.

XLIII.—*Remarks on the Vessels of the Latex, the Vasa propria, and the Receptacles of the elaborated Juices of Plants.* By M. LESTIBOUDOIS\*.

THE older botanists looked upon the coloured fluids in vegetable organisms as peculiar to certain plants, and called them "proper juices." The vessels containing these juices they, moreover, named "proper vessels," and the plants in which such secretions were recognized, laticiferous or lactescent plants.

Besides coloured liquids, other juices, of a completely distinct character, occur in plants, such as gum, resin, oil, &c. Grew termed the receptacles of resinous fluid in the Coniferæ "turpentine-vessels," and those that contained a milky or white fluid "milk-vessels." Linck designated all such organs by the name of "reservoirs of special secretion." Mirbel gave the title of "proper vessels" to all receptacles of special secretion, whether milky, resinous, or oily, calling those "solitary" which were scattered throughout the tissues, and those "fascicular" which were aggregated together. In this latter category he placed the textile fibres of *Asclepias*, of Hemp, &c., although such structures were destitute of laticiferous juices and were, in fact, nothing more than the cortical fibres of those plants.

DeCandolle, whilst recognizing the heterogeneous nature of special secretions, at first regarded them as the nutritive juices of the plants, but subsequently abandoned this opinion (*Organographie*, 1827), and ranged all coloured fluids among secreted products, or those prepared by vesicular glands, and thus established a distinction between them and the juices occupying the lacunæ of the cellular tissue. These latter cavities he agreed with Linck in calling "reservoirs of proper secretion." In his '*Physiologie végétale*,' published afterwards in 1832, although

\* Translated by Dr. Arlidge from the '*Comptes Rendus*' for March 1863.